Mathematics – Engineering Research Workshop
Wednesday 31st May 2017
B001, College of Engineering, Bay Campus

Aim: To build new bridges between the Department of Mathematics and The College of Engineering with a view to establishing new collaborations and the development of joint grant proposals.

Tea and Coffee available on arrival.

13.30 Introduction & Welcome (10min, Professors B. Lucini & S.G. Brown TBC))

13.40 General Overview of Research in Mathematics (20min, Professor B. Lucini)
An overview of current research in the Department of Mathematics, different research groups, active grants, PhD students and postgraduate research, collaboration with external organisations.

14.00 General Overview of Research in College of Engineering
An overview of current research in different research centres in the College of Engineering to be given heads of these research groups or their designates. To include active grants, PhD students and postgraduate research, collaboration with external organisations.

1) Research Centre in Applied Sports, Technology, Exercise and Medicine (A-STEM) (10 min, Prof. G. Stratton)
2) M2A Research Centre (10min, Dr Dai Warren)
3) Systems and Process Engineering Centre (SPEC) (10min, Prof. O. Guy)
4) Zienkiewicz Centre for Computational Engineering (ZCEE) (10min, Dr P.D. Ledger (TBC) for Prof. Nithiarasu (unable to attend))

14.40 Tea and Coffee Break 15min

14.55 Two selected talks from the Department of Mathematics
Nelly Villamizar: Multivariate spline approximation: algebraic tools and applications (20 min talk plus 5 min questions)
Splines are piecewise polynomial functions defined over arbitrary partitions of real domains and satisfying a determined order of smoothness at the places where the polynomial pieces connect. These functions are crucial for geometric modelling and at the same time, a basic object for the numerical approximation of partial differential equations. Because of their very definition, the study of splines involves both algebra and geometry.
In the talk, we will address problems on the construction of spline spaces on meshes of arbitrary topology such as dimension of the space for a fixed order of smoothness, and generation of a basis. The interplay between the underlying combinatorics and geometry of the partition, and the algebraic properties of the resulting set of functions plays a central role in our approach. We will illustrate our method and results by examples of parametric surface constructions.

Pawel Dlotko: **T-Omega formulation of discrete geometrical approach to Maxwell's equations** (20 min talk plus 5 min questions)
In this talk I will present a T-Omega formulation of a Discrete Geometrical Approach to Maxwell's equations. I will show how the counterparts of the laws of electricity and magnetism can be constructed in a topological way, and how topology closes up all the gaps in the model.

15.45 Tea and Coffee Break

16.00 Two selected talks from the College of Engineering
Alexander Shaw : Handling nonlinearity in engineering dynamics (20 min talk plus 5 min questions)
Current industrial practice in engineering is dominated by linear paradigms such as Modal Analysis for the modelling and experimental characterisation of structures and mechanisms. Although these models have proven exceptionally useful, they ignore the fact that nearly all real world systems contain nonlinearity, and this can lead to phenomena, notably bifurcations and chaos, that linear theory cannot describe or model.

This talk presents an outline of work at Swansea University and work by associated researchers that highlights the need to understand nonlinear effects, and progress made in highlighting them. Of particular interest in MDOF is the potential onset of internal resonance, and we show that this is key to the onset of rich dynamics in both static and rotating systems, and can lead to aperiodic responses and chaos. We also discuss the development of new experimental methods aimed at reproducing unstable responses in structures, and means of handling non smooth effects in numerical simulations.

Sanjay Pant: Inverse problems, model identifiability, and uncertainty consideration in models of blood-flow (20 min talk plus 5 min questions)
Mathematical models of biological flows can range from three-dimensional Navier-Stokes equations to reduced-order approximations such as one-dimensional hyperbolic equations representing pulse wave propagation and, on further simplification, to a set of ordinary differential equations. Irrespective of the models chosen, the systems are characterized by a large number of unknown parameters representing material properties and boundary conditions. Typically, some set of measurements, which representing model outputs and are corrupted by both human errors and measurement noise, can be acquired in the patient. A major task then, if the models are to be used for predictions in each patient individually, is to estimate all the model parameters for the patient through this sparse set of uncertain measurements. Such an inverse problem poses three questions: first, is the set of measurements acquired in the patient sufficient for the estimation of all the model parameters (question of model identifiability); second, how should the parameters be estimated with minimal computational cost and while accounting for measurement uncertainty (backward propagation of uncertainty); and third, how does the uncertainty in the estimated model parameters translate to the uncertainty in the predictions made by the model (forward propagation of uncertainty). This talk will present some models for blood-flow modelling in the context of the above three questions and challenging cardiovascular pathophysiologies to assess potential collaborative opportunities with the Department of Mathematics.

16.50 Research Grant Opportunities for Collaborations between Mathematics and Engineering, Julie Griffiths, Bay Research Hub (10min)

17.00 Close.